CLAIMS

1. A method of forming a dielectric film comprising:

incorporating nitrogen into a dielectric film using a nitridation gas and a rapid thermal annealing process, wherein an ultra-low pressure of equal to or less than about 10 Torr is used for the rapid thermal annealing process.

2. The method of forming a dielectric film of claim 1 wherein the nitrogen incorporated into the dielectric film forms a nitrogen concentration peak that occurs at the top surface of the dielectric film.

3. The method of forming a dielectric film of claim 1 wherein the nitrogen incorporated into the dielectric film has a nitrogen concentration equal to or greater than 5%.

4. The method of forming a dielectric film of claim 1 wherein the dielectric film is equal to or less than about 12 angstrom.

5. The method of forming a dielectric film of claim 1 wherein the nitridation agent includes any one of ammonia (NH_3), nitric oxide (NO), and nitrous oxide (N_2O).

6. The method of forming a dielectric film of claim 1 wherein the dielectric film is silicon dioxide (SiO_2).

7. The method of forming a dielectric film of claim 1 wherein after the nitrogen is incorporated, a silicon oxinytride is formed.

8. A method of forming a gate stack comprising:

forming a silicon dioxide film on a substrate;

incorporating nitrogen into the silicon dioxide film using a rapid thermal annealing process and a nitridation gas, wherein the rapid thermal annealing process occurs at about or less than about 10 Torr, the incorporating of nitrogen forming a silicon oxynitride film on the substrate;

continuing the rapid thermal annealing process with nitridation gas for a sufficient amount of time for nitrogen to be incorporated into the silicon dioxide film to form the silicon oxynitride with a nitrogen concentration of about or more than 5%; and

forming a cap layer on the silicon oxynitride.

9. The method of forming a gate stack of claim 8 wherein the rapid thermal annealing process occurs at a temperature between about 900-1100°C.

10. The method of forming a gate stack of claim 8 further comprising:

subjecting the silicon oxynitride to a post annealing process after the silicon oxynitride is formed, wherein the post annealing process occurs at a temperature between about 1000-1100°C.

11. The method of forming a gate stack of claim 10 wherein the post annealing process occurs at a pressure of less than or equal to about 5 Torr.

12. A method of forming a dielectric film comprising:

incorporating nitrogen into a silicon dioxide film using a nitridation gas and a rapid thermal annealing process, wherein an ultra-low pressure of equal to or less than about 10 Torr is used for the rapid thermal annealing process, the incorporating of nitrogen into the dielectric film forming a silicon oxynitride film; and

post-annealing the silicon oxynitride film after a sufficient amount of nitrogen is incorporated into the silicon dioxide film.

13. The method of forming a dielectric film of claim 12 wherein the nitrogen incorporated into the silicon dioxide film forms a nitrogen concentration peak that occurs at the top surface of the silicon dioxide film.

14. The method of forming a dielectric film of claim 12 wherein the nitrogen incorporated into the silicon dioxide film has a nitrogen concentration equal to or greater than 5%.

15. The method of forming a dielectric film of claim 12 wherein the silicon dioxide film is equal to or less than about 12 angstrom.

16. The method of forming a dielectric film of claim 12 wherein the nitridation agent includes any one of ammonia (NH_3), nitric oxide (NO), and nitrous oxide (N_2O).

17. The method of forming a dielectric film of claim 12 further comprises forming the silicon dioxide film.

18. A method of forming a gate stack comprising:

placing a substrate into a first processing chamber of a cluster tool, the cluster tool having a plurality of processing chambers;

forming a silicon dioxide film on the silicon wafer in the first processing chamber;

without breaking vacuum, transferring the substrate from the first processing chamber into a second processing chamber, the second processing chamber capable of running a rapid thermal annealing process at a reduced pressure;

introducing a nitridation gas into the second processing chamber while maintaining pressure of the second processing chamber at about or less than about 10 Torr to form a silicon oxynitride film; and

continuing the nitridation gas into the second processing chamber for a sufficient amount of time for nitrogen to be incorporated into the silicon dioxide film to a nitrogen concentration of about or more than 5%.

19. The method of forming a gate stack of claim 18 comprising:

maintaining a temperature between about 900-1100°C while the nitridation gas is being introduced.

20. The method of forming a gate stack of claim 18 comprising:

subjecting the substrate to a post annealing process after the silicon oxynitride is formed, wherein the post annealing process occurs at a temperature between about 1000-1100°C.

21. The method of forming a gate stack of claim 20 wherein the post annealing process occurs in a third processing chamber.

22. The method of forming a gate stack of claim 20 wherein the post annealing process occurs at a pressure of about 5 Torr.

23. A silicon oxynitride film wherein a nitrogen concentration in the silicon oxynitride film is greatest at the top surface of the film and decreasing with depth, the silicon oxynitride film is free of unassociated nitrogen.

24. A method of treating a dielectric film comprising:

exposing the dielectric film to a nitridation gas at a pressure equal to or less than about 10 Torr;

subjecting the dielectric film to a rapid thermal annealing process during the exposing of the dielectric film to the nitridation gas to

incorporate nitrogen into the dielectric film to form a silicon oxynitride film.

25. The method of treating a dielectric film of claim 24 wherein the nitridation gas includes any one of ammonia (NH_3), nitric oxide (NO), and nitrous oxide (N_2O).

26. The method of treating a dielectric film of claim 24 wherein the dielectric film is silicon dioxide (SiO_2).

27. The method of treating a dielectric film of claim 24 wherein after the nitrogen is incorporated, a silicon oxinytride is formed.

28. The method of treating a dielectric film of claim 24 wherein the rapid thermal annealing process occurs at a temperature between about 900-1100°C.

29. The method of treating a dielectric film of claim 27 further comprising:

subjecting the silicon oxynitride to a post annealing process after the silicon oxynitride is formed, wherein the post annealing process occurs at a temperature between about 1000-1100°C.

30. The method of treating a dielectric film of claim 29 wherein the post annealing process occurs at a pressure of less than or equal to about 5 Torr.

31. The method of treating a dielectric film of claim 24 wherein the subjecting the dielectric film to the rapid thermal annealing process is continued until a concentration of nitrogen of at least about 5% is incorporated into the dielectric film.

32. The method of treating a dielectric film of claim 27 further comprising subjecting the silicon oxynitride film to a post-annealing process wherein the silicon oxynitride is post annealed in a non-nitridation atmosphere after a desired concentration of nitrogen is incorporated into the dielectric film.